

Pottersburg Creek and Walker Drain

2008 PCB Sampling Results



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INTRODUCTION

At the Public Information Session held May 9, 2008 to introduce the Pottersburg PCB Storage Site decommissioning project, the Ministry of the Environment was asked what the PCB levels in Pottersburg Creek are like now, 20 years after the cleanup of the creek.

This document and the attached scientific report answer that question, by providing what the ministry found in its sampling and testing of sediment, water, fish and clams from Pottersburg Creek in the summer of 2008. This document explains the study purpose, results and proposed next steps.

PURPOSE

Before it was cleaned up in the 1980s, Pottersburg Creek contained high levels of PCBs. The goal of the sampling was to assess the 2008 levels of PCBs in the creek and its aquatic life. This would tell ministry experts whether the levels are as low as they were after the 1980s cleanup. If they are, we could be confident that there was no concern for human health and a low risk to the ecosystem. A sampling study like this shows whether a human health or ecological risk assessment should be considered if levels are high enough to be a concern. Using the findings the ministry has assessed what the PCB levels in the creek mean for human health and the environment.

KEY FINDINGS

The sampling results show that small amounts of PCBs are still present in Walker Drain, Pottersburg Creek and the Thames River. PCB levels in the Pottersburg Creek ecosystem have continued to decline in fish, clams and water. PCB levels in sediment remain similar to the levels after the clean-up. The ministry has concluded that the levels of PCBs found in water and sediment in this study are within or well below the limits that the ministry considers acceptable from a human health perspective. While some ecological standards are exceeded, particularly in Walker Drain where PCB levels are higher, the levels remain low enough that they do not pose a significant risk to the environment. A closer study of Walker Drain is necessary to find the cause. The ministry has shared these findings with the Middlesex-London Health Unit and continues to work closely with its partners.

The levels of PCBs in Thames River carp remain high enough that sport fish advisories are in place downstream of Pottersburg Creek. The ministry encourages people to follow the recommendations in the ministry's *Guide to Eating Ontario Sport Fish*.

BACKGROUND

In 1980, routine monitoring by the Ministry of the Environment revealed elevated PCB levels in minnows collected from the Thames River, near the mouth of Pottersburg Creek. This prompted the ministry to conduct a detailed assessment of the area, including a section of Pottersburg Creek and Walker Drain.

The ministry discovered three industrial sources of PCB contamination, primarily the former Westinghouse site but also Wolverine Tube and GM Diesel. Large-scale remediation projects were conducted from 1984 to 1987 in Pottersburg Creek, Walker Drain and on the three industrial properties. Some additional clean-up work was done in 1988 due to recontamination of the creek sediment.

A clean-up target concentration of one part per million (1 ppm) of total PCBs was set for the sediment in the creek. This target was set by a multi-stakeholder technical review committee that considered the characteristics of PCBs, the extent of the contamination, and the potential hazard to public safety, the environment and remediation workers.

PCB levels in the creek were monitored after the cleanup until 2000. The monitoring showed that PCB levels in the creek sediment had dropped dramatically and stabilized at a much lower level.

2008 SAMPLING OF POTTERSBURG CREEK AND WALKER DRAIN

In 2008, the ministry began a decommissioning project for the Pottersburg PCB Storage Site in London to meet a federal deadline of 2010 for the decommissioning of all PCB storage sites. The site contains the material from the cleanup conducted in the 1980s. At a public meeting on May 9, 2008 a request was made for information on the current PCB levels in Pottersburg Creek. The ministry made a commitment at that meeting to update the monitoring data and report back to the public.

The sampling was conducted in the summer and fall of 2008. Sediments, clams, water and fish were collected. A total of 11 locations were sampled in Walker Drain, Pottersburg Creek and the Thames River. The samples were tested for PCB concentrations and the results are reported here compared to guidelines, objectives and standards.

SPORT FISH RESULTS (THAMES RIVER)

Carp, smallmouth bass and rock bass were collected from the Thames River both upstream and downstream of Pottersburg Creek. PCB levels in carp and smallmouth bass from the Thames River were significantly higher downstream of Pottersburg Creek compared to the Thames River upstream location.

Based on PCB levels, consumption restrictions for carp remain in place and are outlined in the *Guide to Eating Ontario Sport Fish*. Consumption advisories are more restrictive downstream of Pottersburg Creek. Although PCB concentrations in carp have declined since the 1980s, the restrictions remain in place because the levels exceed the 0.211 ppm consumption limit. PCB levels for smallmouth bass and rock bass were below the consumption restriction level and so there are no consumption advisories for these fish.

The 2009/2010 guide indicates that carp consumption should be restricted to fewer than four meals a month. Women of child-bearing age and children under 15 years of age should not eat carp longer than 22 inches.

Sport fish sampling has not been conducted in Pottersburg Creek. The creek serves primarily as a spawning and nursery area for south Thames River sport fish. Unless the fish are caught when they are spawning, most would be too small for consumption. It is possible but not likely that people are catching spawning pike, resident rock bass or coarse fish for consumption from the creek. The Thames River sport fish results were used to update the fish consumption advice in the ministry's *2009-2010 Guide to Eating Ontario Sport Fish*.

CLAM RESULTS

The highest PCB levels were observed in Walker Drain, at 0.057 to 0.080 ppm with a decreasing trend downstream. Walker Drain flows into Pottersburg Creek.

PCBs are entering the Thames River from Pottersburg Creek. However, the levels in clams were considerably lower than those found in past studies.

The guideline for PCBs in fish (0.1 ppm) was set to protect fish-eating wildlife so it does not normally apply to clams. Since the guideline has been used as the benchmark for Pottersburg clam monitoring since the 1980s it was used for this study.

The guideline was not exceeded so a further assessment is not necessary.

YOUNG OF YEAR FISH RESULTS

The PCB levels in minnows have decreased since the 1990s.

Guideline exceedances (levels above 0.1 ppm) were observed at four of seven locations with one located in Walker Drain and three in Pottersburg Creek.

PCB levels were highest in Walker Drain creek chub (0.283 ppm) and the levels were significantly higher than those found in fish from the six other sampling locations.

Juvenile fish PCB levels were significantly higher in Pottersburg Creek than those in the Thames River.

PCB levels in juvenile fish exceeded the guideline for the protection of fish-eating wildlife at some sampling sites. The results of studies of more contaminated creeks tell us that the levels are not high enough to pose a significant threat. The findings warrant further sampling to understand why PCB levels are higher in Walker Drain.

SEDIMENT RESULTS

PCBs are present in sediments in Walker Drain, Pottersburg Creek and the downstream area of the Thames River. The highest levels were found at or near Walker Drain (0.37 and 0.47 ppm).

PCB levels observed in 2008, particularly near Walker Drain, were higher than those observed in 1991 but still within the same concentration range, so the current sediment levels have not significantly increased.

Sediment PCB levels were above the Provincial Sediment Quality Guideline Lowest Effect Level (0.07 ppm) but were below the creek cleanup target of 1 ppm.

The sediment quality guideline is designed to protect sediment-dwelling aquatic life forms and it was set by the ministry in 1993 after the cleanup was complete. The guideline is not useful as a cleanup target because it does not account for the main concern, which is PCB accumulation in the food chain. The guideline is used to assess potential impacts on bottom-dwelling aquatic life.

The 2008 results show that the sediment PCB concentrations may pose a minor risk to these aquatic life forms. Follow-up is required to understand why PCBs are higher in Walker Drain.

WATER RESULTS

The highest levels of water-borne PCB concentrations were identified at or near Walker Drain (0.0167 and 0.0248 parts per billion or ppb). The levels of PCBs in the other sites sampled were lower (0.000174 to 0.00487 ppb).

Total solids were also elevated (703-1000 ppm) in Walker Drain relative to the other sampling sites. As PCBs are not easily soluble in water and are usually found attached to sediment suspended in the creek flow, this may account for the elevated levels of PCBs in the samples from Walker Drain.

All sites that were sampled, except the furthest upstream site, were above the Provincial Water Quality Objective, which is set to protect aquatic life (0.001 ppb). It is not unusual for PCB levels to exceed the PWQO in urban creeks.

Based on the results of studies of other creeks, the 2008 PCB concentrations in water are low enough that risk to aquatic life is low. Follow-up is required to understand why PCBs are higher in Walker Drain.

CONCLUSION

HEALTH-BASED LIMITS

According to Health Canada, everyone is exposed to very small amounts of PCBs through food, and to a lesser extent, air, soil and water. Current knowledge suggests that low-level exposures to PCBs are unlikely to cause adverse health effects. People who eat large amounts of certain sport fish, wild game and marine mammals are at increased risk for higher exposures and possible adverse health effects.¹

While the attached report is not a human health risk assessment, the study findings are assessed against health-based limits for PCBs so that we can understand what the PCB levels in the creek mean to people who may be exposed. One of the ways that people can be exposed to PCBs is by contact with creek sediment and water.

Body contact with the sediment could occur by wading barefoot in the creek. This study found that sediment PCB levels were less than 1 part per million (ppm) and below Ontario's current limit of 5 ppm for use, under the Environmental Protection Act.² The levels are also below the drinking water standard (0.003 ppm) if creek water were accidentally swallowed.

People may also be exposed to PCBs via sport fish, which take up PCBs from the sediment or water. Sport fish consumption restrictions for carp remain in place as a result of PCB and other chemical concentrations in fish from the Thames River just downstream of the creek. For the general human population, the main source of exposure to PCBs is through the food chain by consuming meat, fish and dairy products contaminated with PCBs. People do not eat the types of clams or minnows (*juvenile or young-of-the-year* fish) that were sampled in this study.

¹ Health Canada, It's Your Health fact sheet on PCBs, www.hc-sc.gc.ca/hl-vs

ECOLOGICAL GUIDELINES

The study shows that PCBs are present in the creek sediment. Levels remain low and the sediment still meets the 1 ppm cleanup target set during the 1980s based on the potential hazards of PCBs and the extent of contamination.

The PCB levels in sediment are above the Low Effect Level of the ministry's sediment quality guideline,² which is a concentration that can be tolerated by most of the animals that live in the sediment. The PCB levels are well below the Severe Effect Level, which is a concentration expected to be harmful for most of the animals living in the sediment.

When PCB levels are found to be above the Low Effect Level but well below the Severe Effect Level a closer look at the possible effect on the environment is needed but does not mean that impacts are happening.

The ministry has compared these results to some recent risk assessments that estimate the PCB exposure of aquatic wildlife at other more contaminated creeks. Based on the findings of these other assessments, the lower PCB levels found in this study are unlikely to pose a significant risk to the environment.

OTHER FINDINGS

All of the different types of creek samples studied (sediment, clams, fish and water) show higher PCB levels in Walker Drain. A closer study of Walker Drain is necessary to find the cause. This could present an opportunity to improve water quality. Storm water flows to Walker Drain come from sewers in the Clarke Sideroad, Oxford Street and Cheapside Street area. Walker Drain discharges to Pottersburg Creek at Culver Drive.

² Ministry of the Environment, Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, March 9, 2004.

NEXT STEPS

HUMAN HEALTH

This study was done to assess PCB concentrations in the Pottersburg Creek now, more than 20 years after the cleanup in the 1980s. While this study was not designed to be a human health study, ministry experts in toxicology and risk assessment looked at what the levels in this study mean for human health. To do this these experts compared the results to health-based limits, assumed some possible exposure scenarios, and considered the findings of studies of similar situations in Ontario.

In considering the possible health effects of the levels of PCBs found in this study it is assumed that humans could be exposed in a recreational or accidental way to sediment, creek water and sport fish only, as humans do not consume clams or juvenile fish.

Table 1. 2008 Ministry Study Results and Health-based Limits

TYPE OF SAMPLE	LEVEL FOUND	HEALTH-BASED LIMIT	COMMENT
Sediment	0.009 – 0.47 ppm	5 ppm (soil) [proposed new limit 0.3 ppm (soil)]	Within or below limit
Water	0.000174-0.0248 ppb	3 ppb	Below limit
Sport Fish	Not Detected – 0.54 ppm	0.105 ppm (4 meals per month) 0.211 ppm (2 meals per month)	Sport Fish advisory - carp

Table 1 compares the levels found in this study to health-based limits. The PCB levels and health-based limits are shown in parts per million (ppm), with the exception of water which is in parts per billion (ppb).

In addition to this comparison, a ministry toxicologist has compared the levels found here to other similar sites in Ontario where levels were high enough that a full human health risk assessment was needed. For example, a risk assessment for Lyons Creek East in Welland, Ontario found that recreational exposure of a child to PCB levels of 22 ppm would not be expected to result in adverse human health effects. The highest

level of PCBs found in this study is 0.47 ppm in Walker Drain, a level which is more than 40 times lower than Lyons Creek East.

The ministry has concluded that the levels of PCBs found in water and sediment in this study are within or well below the limits that the ministry considers acceptable from a human health perspective and are low enough that a full human health risk assessment is not considered necessary.

ECOSYSTEM AND ENVIRONMENT

PCBs are present in water, sediment and fish in the Pottersburg Creek Watershed. The PCB levels found are slightly higher than a typical urban area comparable to London but well below the levels found at other sites that have required risk assessments and cleanups. The ministry has assessed the PCB levels that are present and is confident that they are not a significant threat to aquatic life or wildlife.

The ministry is following up to identify the source and cause of higher PCB levels in the Walker Drain area. Additional sampling will be carried out in Walker Drain and upstream sewers for identifiable sources. If a controllable source is found, the ministry will require the responsible parties to deal with it.

APPENDIX A

Overview of PCB concentrations in Pottersburg Creek

MOE report
to
Southwestern Region
from
Environmental Monitoring and Reporting Branch.

May 2009
Updated November 2009

INTRODUCTION

In 1980, MOE routine monitoring of PCB concentrations in juvenile fish (common shiner) found elevated levels of PCB in the Thames River downstream of Pottersburg Creek. Subsequent monitoring revealed that much of the creek sediment from Walker Drain down to the Thames River was contaminated with PCBs.

Remedial measures for creek clean-up from 1985 to 1987 included industrial source control, large-scale dredging of creek sediment, floodplain soil removal and floodplain capping to secure the remaining PCB residue. In 1988, some sediment re-contamination was found in Pottersburg Creek, Walker Drain, and upstream storm sewers so the remediation was not finalized until 1989.

This report is not a human health risk assessment but rather an assessment of the current status of PCB levels in Walker Drain, Pottersburg Creek and the Thames River.

A 2008 Regional Request was submitted by the London District Office to the Environmental Monitoring and Reporting Branch (EMRB) requesting the services of EMRB to update monitoring data with respect to PCBs in sediments, water, and biota from Pottersburg Creek. Field work was conducted between July and September 2008. To allow comparisons to historical data, sampling locations for various media were based on historical sample locations (Figure 1). An upstream reference located at Nissouri Road (Figure 1, POTT1) was also sampled for all media types (i.e. biota, sediments, water) to provide an indication of background levels.

PCBS IN THE ENVIRONMENT

PCBs or polychlorinated biphenyls are a group of synthetic chemical compounds which were produced primarily for use in electrical and heat transfer equipment. Due to their inherently hazardous properties (persistence, bioaccumulation and toxicity), PCB manufacture in North America was banned in 1977 and usage was limited to existing electrical transformers.

The scientific literature indicates that PCBs are inert and thermally/physically stable which means they can persist for years in the environment with minimal breakdown. PCBs have very low solubility in water and high accumulation factors in soil, sediment and in the fatty tissues of animals. Once contaminated, soil and sediment serves as an ongoing source of exposure to aquatic life, wildlife and humans. PCBs found in water are mostly attached to suspended solids. Large storm events can scour contaminated river sediment and carry it from its source downstream where it is then re-deposited back into the sediment.

PCBs can be absorbed and stored in animal fatty tissue via several exposure routes. The main concern is PCB bioaccumulation to high concentrations as it moves up the food

chain through fish, birds, and mammals. For the general human population, the main source of exposure is through the food chain; primarily through the consumption of meat, fish and dairy products contaminated with PCBs.

METHODS

On July 3, clams were deployed at 9 of the 11 locations in the creek (Table 1, Figure 1). Six clams were placed into mesh wire envelopes and secured to a fixed location in the stream for a period of three weeks. Upon retrieval, (July 24th), clams were shucked in the field and transported on ice for submission to the Ministry of the Environment laboratory for analysis of PCBs, and lipid content.

Surficial sediments were also collected from all clam deployment sites, with the exception of one site at Gore Road (Table 1, Figure 1, and POTT7) where sediment type was composed of hard clay and unsuitable for sampling. Soft silty sediments were targeted for sediment collection and the samples were made up of a composite of 5-10 samples collected from depositional areas along the stretch of creek. Sediments were also collected from two additional locations, at the mouth of Pottersburg Creek (POTT7A), located downstream of the clam deployment location POTT7 and from Second Street (POTT5A), upstream of Kiwanis Park. Sediments were sampled on the same day as clam retrievals (July 24th) and submitted to the MOE laboratory for analysis of congener-specific and total PCBs, total organic carbon, and particle size.

Although PCB concentrations in water are typically low and below detection limits, due to interest from the Regional Office water was sampled during clam retrievals from selected locations. Locations included the Walker Drain (Table 1, Figure 1, POTT2 & 3), the reference site at Nissouri Road (POTT1), downstream of Third Street (POTT 5), at Second Street (POTT5A), at Wavell Street in Kiwanis Park (POTT6), and at the mouth of the Creek (POTT7A). Water samples were collected from just below the surface of the creek, taking care to disturb the sediments as little as possible. Samples were submitted to the MOE laboratory for analysis of congener-specific PCBs.

Young of the year juvenile fish and sport fish were also collected in early September 2008. In total, seven locations were sampled for young of the year juvenile fish (Table 1, Figure 1). The juvenile fish collected at each site were divided into multiple composite samples made up of 5-10 individual fish. Sport fish were collected in the Thames River, upstream and downstream of Pottersburg Creek and a skinless, boneless fillet was taken from each fish. All were analyzed for PCBs and lipid content.

A summary of the sampling design is provided in Table 1.

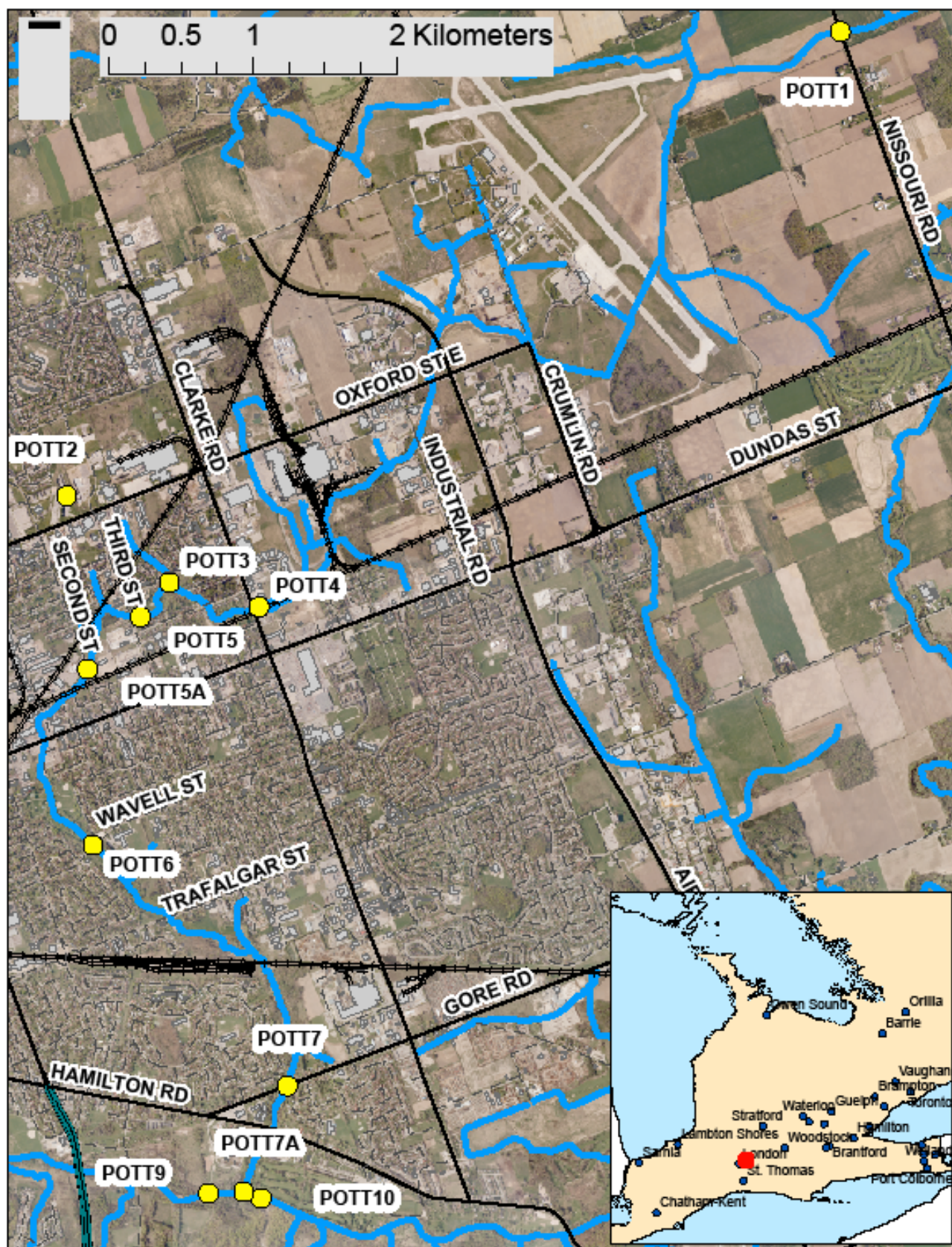


Figure 1. Sites sampled in 2008 in Pottersburg Creek .

Table 1. Sampling strategy for Pottersburg Creek											
	POTT1	POTT 2	POTT3	POTT4	POTT5	POTT6	POTT7	POTT7A	POTT5A	POTT9	POTT10
Sediments	✓	✓	✓	✓	✓	✓	--	✓	✓	✓	✓
Water	✓	✓	✓	✓	✓	✓	--	✓	✓	--	--
Clams	✓	✓	✓	✓	✓	✓	✓	--	--	✓	✓
Juvenile Fish	✓	--	collected in creek just ds of drain	✓	--	✓	✓	--	--	✓	collected further upstream from POTT10
Sport Fish										✓	✓
POTT1	Nissouri Creek										
POTT 2	Walker Drain -downstream of concrete dam										
POTT3	Walker Drain - Culver Dr.										
POTT4	Clarke Rd.										
POTT5	3rd St. under bridge										
POTT6	Wavell St.										
POTT7	Gore Rd.										
POTT7A	Mouth of Pottersburg Creek										
POTT5A	Second St.										
POTT9	Downstream of Pottersburg Creek in Thames River										
POTT10	Upstream of Pottersburg Creek in Thames River										

Monitoring results were compared to historical data and to applicable objectives or guidelines for assessing potential impacts to aquatic biota, benthic organisms, and wildlife consumers. As PCBs are the primary contaminant of concern, this report primarily focuses on PCB concentrations in the creek.

RESULTS

The Province of Ontario has set guidelines for the allowable limits of PCBs in sediments and water. The provincial government also uses guidelines from other jurisdictions where no specific Ontario guideline exists (e.g. juvenile fish).

The Provincial Sediment Quality Guidelines (PSQGs)¹ are biologically based guidelines. The Lowest Effect Level (LEL) is the level at which no effect to the majority of sediment-dwelling organism is observed. The LEL for PCBs is set at 0.07 ppm. The LEL is derived from field based data on the co-occurrence of sediment concentrations and benthic species. Derivation of the LEL is a two part process; occurrence data is plotted against the PCB concentration for each species, the 90th percentile for each species considered is then plotted. The 5th percentile from this information is then used as the LEL. The Severe Effect Level (SEL) is set at 530 ppm (corrected for total organic carbon). The SEL indicates the level of PCBs contamination at which pronounced disturbance of the sediment-dwelling community can be expected.

The Provincial Water Quality Objective (PWQO)² for PCBs is a concentration of 0.001 parts per billion (ppb) of water which aims to be protective of all forms of aquatic life.

¹ MOE, 2008. Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario: An integrated approach. May 2008. Ministry of the Environment, Toronto, Ontario.

² MOEE, 1994. Water Management Policies, Guidelines, Water Quality Objectives. Ministry of the Environment and Energy. July 1994

The PWQO for PCBs is based on a review of toxicological literature. The value for the PWQO is then set at the lowest concentration at which an effect is observed from any of the endpoints considered (toxicity, bioaccumulation and mutagenicity) with 10-fold safety factor added.

PCB levels in sport fish tissue are compared to consumption limits calculated from health protection guidelines (Tolerable Daily Intakes or TDIs) developed by Health Canada. Consumption advisories give the recommended maximum number of monthly meals of sport fish (8, 4, 2, 1 or 0 meals per month) based on the contaminant concentrations in the fish samples. These advisories are specific to the species and the length of fish and the location where the fish was caught. Advisories are provided separately for the general population and the sensitive population (i.e. women of childbearing age and children under 15).

PCB levels in juvenile fish tissue were compared to the International Joint Commission (IJC)³ guideline of 0.1 ppm. This level is set to protect fish-eating wildlife from possible effects caused by bioaccumulation of PCBs.

Surficial Sediment

In this report, total PCBs in sediments are based on the sum of congeners above detection limits as this method provides the best estimate of total PCB concentrations. Total PCBs were also analyzed (different analytical method) and found to be comparable to congener-specific totals. It should be noted that historically PCBs were only analyzed as totals.

PCB concentrations were below the Provincial Sediment Quality Guidelines (PSQG) Lowest Effect Level (LEL) at the upstream Pottersburg Creek and upstream Thames River locations (POTT1 and POTT10 respectively) (Figure 2 & Table 2). All other locations exceeded the LEL, but no sites exceeded the Severe Effect Level (SEL). PCB concentrations downstream of the GM plant (POTT4) only marginally exceeded the LEL at 0.08 ppm. The highest levels of PCBs were observed in the Walker Drain (POTT2 and POTT3: 0.37 – 0.47 ppm), suggesting that Walker Drain or its inputs may be contributing PCBs to Pottersburg Creek. Elevated levels of PCBs in the Thames River, downstream of the confluence with Pottersburg Creek, suggest that Pottersburg Creek may be contributing PCBs to the Thames River. However, concentrations of PCBs in the sediments taken in this study were considerably lower than those observed in 1988⁴ at similar sites (Table 2). PCB concentrations from the vicinity of Walker

³ IJC, 1988. 'Revised Great Lakes Water Quality Agreement of 1978, as amended by protocol signed November 18, 1987'. International Joint Commission, 130 pp.

⁴CH2M Hill, 1989. Short term monitoring program for Pottersburg Creek watershed (including upstream storm sewers and the Walker Drain)

Drain in 1988 ranged from 1.5 - 8 ppm. Concentrations observed in the Walker Drain from this study are generally an order of magnitude lower than those observed in 1988. At the furthest downstream location (Table 2), concentrations ranged from 0.49 – 2.6 ppm in 1988 compared to 0.18 ppm at the Creek mouth in this study.

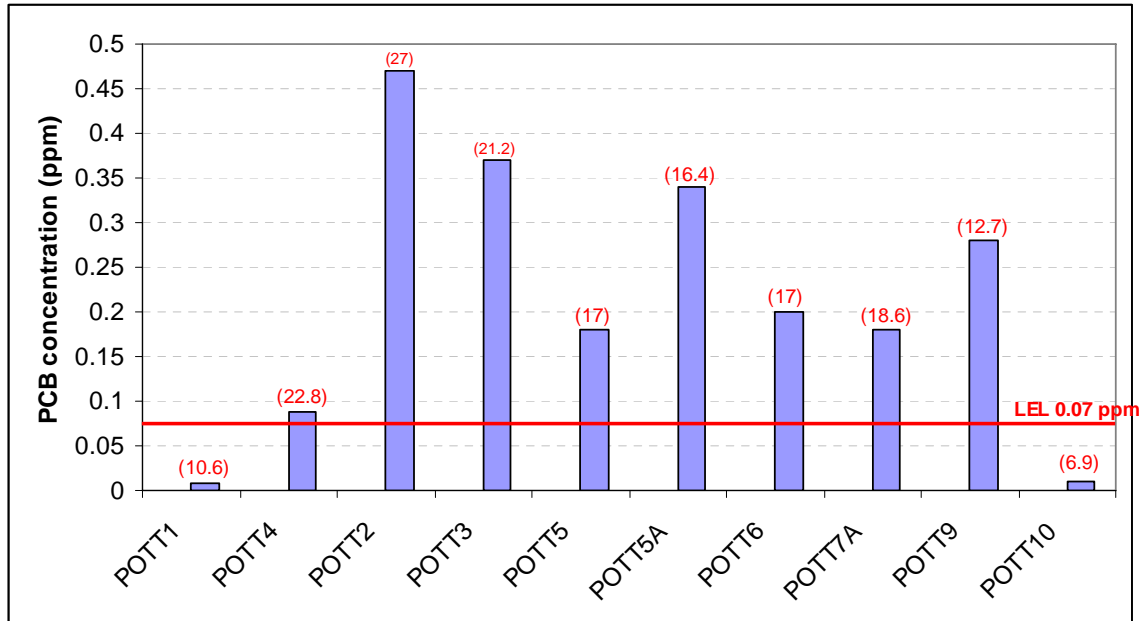


Figure 2. Concentration of total PCBs in sediment from Pottersburg Creek. Numbers in parentheses indicate the site specific Severe Effect Level corrected for total organic carbon (TOC)

Table 2. Summary of PCB concentrations observed in sediment (ppm) from Pottersburg Creek and the Thames River in the vicinity of Pottersburg Creek for the MOE 2008 study and findings from past investigations. Highlighted cells exceed the PSQG* LEL of 0.07 ppm.

Source	year	U/S ref	U/S	U/S	PC D/S	Second St	Wavell Rd	Gore Rd	Mouth of	D/S	U/S
		POTT1	D/S GM	Walker Drain	Walker Drain	Walker Drain	POTT5A	POTT6	PC	Thames R	Thames R
MOE	2008	0.009	0.088	0.47	0.37	0.18	0.34	0.2	0.18	0.28	0.011
		U/S ref	D/S GM	U/S	Walker Drain	PC D/S	Second St	Wavell Rd	Gore Rd		
			P2	Walker Drain	P3	Walker Drain	P5/6	P8	P11		
CH2M HILL ⁴	1988		<0.02**	2.45-8	1.5-6.5	<0.02**	<0.02**	0.09-1.7	0.49-2.6		
MOE	1991		<0.02**	0.18	0.82	0.04	0.045	0.25	0.03		

*PSQG MOE (2008) Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario: An integrated approach. May 2008. Ministry of the Environment, Toronto, Ontario.
 **<0.02= results below detection

A study carried out in 1991 by the MOE⁵ provided follow-up sediment sampling to the CH2M Hill work, and samples were collected at the same sites as the 1988 work. PCB concentrations were much lower than those observed in 1988 and ranged from below the detection limit downstream of the GM plant (Table 2, P2) to 0.82 ppm at Walker Drain

⁵ MOE, 1991. Internal memo from B. Hawkins to D. Frier. Re: Pottersburg Creek PCB remediation sediment sampling. November 21, 1991.

(P3). PCB concentrations observed in this study were marginally higher than those observed in the 1991 MOE study, but remained within the same order of magnitude, which suggests that PCB concentrations have remained stable at post clean-up levels.

Surface Water

Total PCBs were measured as the sum of congeners above detection limits in water. This method provides the best estimate of actual PCB concentrations. Historically, PCBs have been measured as totals using a different analytical method that has much higher detection levels (0.02 ppb). Actual concentrations measured using the historic method are less accurate than the congener derived totals and are best suited to assess the presence or absence of elevated PCBs rather than actual concentrations. Due to differences in analytical methods, results between the two methods are not directly comparable.

PCBs in surface waters were above the PWQO at all sites except the upstream reference at Nissouri Road (POTT1). Concentrations were highest in or near Walker Drain (POTT 2 and 3), and decreased further downstream. Total solids were also elevated in Walker Drain (703 - 1000 ppm) relative to other sites (413-607 ppm), and may be responsible for the higher PCB concentrations measured in water samples from here as samples analyzed were unfiltered. PCB levels at one station upstream of Walker Drain (POTT4) were just above the PWQO; however, slight elevations above the PWQO are often detected in urban creeks. Overall, these data suggest that Walker Drain and its inputs may be contributing PCBs to Pottersburg Creek.

Elevated PCBs, measured as totals, were also detected in Walker Drain in 1988 and 1990 (Table 3). A study by CH2M Hill detected elevated levels during several low and high flow sampling events in 1988. Zaranko et al. (1997) detected PCBs in the Walker Drain after three rain events in 1990, although PCBs were not detected at other sampling events (from 1998-1993) in their study. Concentrations detected in these two studies were generally much higher than levels measured in 2008; however, results should be interpreted with caution given differences in analytical methods used to measure total PCBs. Because most of the 2008 samples were below 0.02 ppb, it is likely that had the samples been analyzed using the older method, PCB levels would not have been detected.

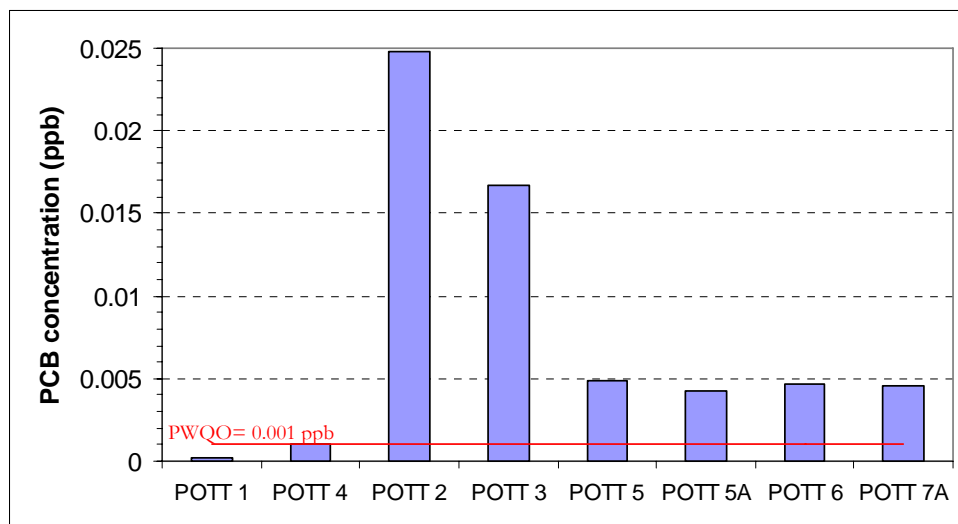


Figure 3. Concentration of total PCBs in surface water from Pottersburg Creek.

Table 3. Summary of PCB concentrations observed in water (ppb) from Pottersburg Creek and the Thames River in the vicinity of Pottersburg Creek for the MOE 2008 study and findings from past investigations. Highlighted cells exceed respective PWQO* of 0.001 ppb.

Source	Year	U/S ref POTT1	D/S GM POTT4	U/S Walker Drain POTT2	Walker Drain POTT3	PC D/S Walker Drain POTT5	Second St POTT5A	Wavell Rd POTT6	Gore Rd POTT7	Mouth of PC POTT7A	D/S Thames R POTT9	U/S Thames R POTT10
MOE	2008	0.000174	0.00106	0.0248	0.0167	0.00487	0.0042	0.00468		0.00456		
		U/S ref	D/S GM	U/S Walker Drain	Walker Drain	PC D/S Walker Drain	Second St	Wavell Rd	Gore Rd	Mouth of PC	D/S Thames R	U/S Thames R
			P2	P1	P3	P4	P5/6	P8	P11			
CH2M HILL†	1988 low			<0.02**	0.08	<0.02**	0.59					
	1988 high			0.03-3.05	0.05							
Zaranko et al. (1997)	1989-1993				<0.02**	0.33						

PWQO* MOE, 1994. Water Management Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of the Environment and Energy. Ministry of Environment and Energy, Toronto, Ontario

**<0.02= results below detection limit

† Water quality data is based on the range from low and high flow event sampling in Walker Drain

Caged Clams

Observed PCB concentrations in the clams are shown in Figure 4. Clam concentrations ranged from trace levels (<0.02 ppm) in the Balsam Lake reference samples, and upstream Thames River and Pottersburg Creek references to a maximum of 0.08 ppm in the Walker Drain. PCB concentrations in the clams from the Walker Drain were significantly higher than those observed upstream of the Walker Drain and in the Thames River. A distinct decreasing concentration gradient in PCB concentrations was observed downstream of the Walker Drain, with PCB levels in the Thames River downstream of Pottersburg Creek higher than those upstream of the creek. Although the PCB concentrations in the clams from the Thames River do not significantly differ from each other, the observed trends suggest that PCBs are entering the Thames River from Pottersburg Creek.

Concentrations of PCBs in the clams of this study were considerably lower in the vicinity of Walker Drain than those observed in caged clam studies conducted in 1984 and 1987⁶, and 1989⁷ at similar sites to those outlined in this study (Tables 1 and 4). Prior to and immediately after abatement measures and sediment removal, PCB concentrations from the Walker Drain ranged from 1.48 - 1.99 ppm in 1984 to 0.05 - 0.47 ppm in 1987, respectively. Concentrations of PCBs observed in Walker Drain from this study are more than an order of magnitude lower than that observed in 1984, and about half that observed in 1989 (Table 4).

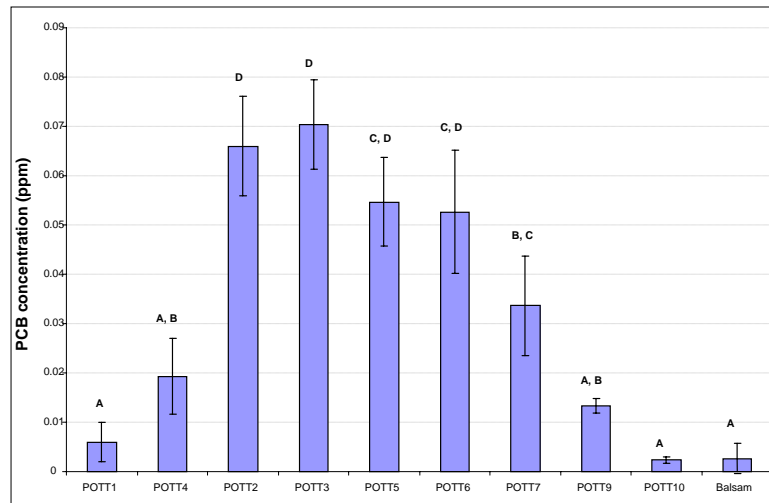


Figure 4. PCB concentrations in clams deployed in Pottersburg Creek and the Thames River. Sites with the same letters do not significantly differ from each other (ANOVA, $p < 0.05$)

⁶ Aquatic Ecotudies Limited, 1989. Effect of source control and stream sediment removal on the bioaccumulation of PCBs by *Elliptio Complanata* in Pottersburg Creek, London Ontario

⁷ MOE, 1989. Technical memorandum of: Biomonitoring (using *Elliptio Complanata*) assessment of Pottersburg Creek June 19 to July 10, 1989. Water Assessment Unit. MOE. October 1989

Table 4. Summary of PCB concentrations observed in clams (ppm) from Pottersburg Creek and the Thames River in the vicinity of Pottersburg Creek r for the MOE 2008 study and findings from past investigations. Highlighted cells exceed the IJC guidelines for the protection of fish eating wildlife of 0.1 ppm.

Source	Year	U/S ref POTT1	D/S GM POTT4	U/S Walker Drain POTT2	Walker Drain POTT3	PC D/S Walker Drain POTT5	Second St POTT5A	Wavell Rd POTT6	Gore Rd POTT7	Mouth of PC POTT7A	D/S Thames R POTT9	U/S Thames R POTT10	Balsam
MOE	2008	0.002-0.01	0.011-0.026	0.057-0.077	0.062-0.080	0.049-0.065		0.044-0.067	0.028-0.043		0.012-0.015	0.002-0.003	0.002-0.006
		U/S ref 1	D/S GM 3	U/S Walker Drain 5	Walker Drain 6	PC D/S Walker Drain 7	Second St 8	Wavell Rd 9	Gore Rd 12	Mouth of PC 13	D/S Thames R 15	U/S Thames R 14	
Aquatic	1984	-	-	0.73-1.89	1.48-1.99	0.11-1.5	0.13-0.71	0.25-0.83	0.08-0.16	0.16-0.26	-	-	
Ecostudies	1987	<0.02	0.22-0.246	1.88-2.66	-	1-1.68	0.72-1.64	0.828-1.63	0.45-0.797	0.527-0.659	<0.02-0.141	<0.02-0.303	
Ltd ⁷	1987	<0.02	0.06-0.09	1.2-2	0.05-0.47	0.46-0.55	0.01-0.15	0.13-0.16	0.01-0.05	0.05-0.09	0.05	<0.02	
MOE	1989	<0.02	<0.02-0.06	0.13-0.17	<0.02- 0.13	0.13-0.17		0.1-0.13	<0.02	<0.02	<0.02	<0.02	

IJC⁷⁷ IJC (International Joint Commission) (1988) Revised Great Lakes Water Quality Agreement of 1978, as amended by protocol signed November 18, 1987. 130pp. International Joint Commission

Juvenile Fish

Samples collected in 2008 showed PCB levels exceeding the International Joint Commission (IJC) guideline for the protection of fish-eating wildlife of 0.1 ppm at 4 of the 7 sites, with the highest values in creek chub collected immediately downstream of the Walker Drain (Figure 5). Due to the fact that different species of juvenile fish were collected at the Pottersburg Creek sites, PCB concentrations in the fish were lipid-corrected before statistical comparisons were made. A significant difference in lipid corrected PCB concentrations in juvenile fish between sites was observed ($p < 0.05$); PCBs from juvenile fish collected in the vicinity of Walker Drain were significantly higher than all sites except POTT6 located at Wavell Street in Kiwanis Park (Figure 5; $p < 0.05$). A decrease in PCB concentrations was observed downstream with fish collected at the lower end of the Creek (POTT7) having lipid corrected PCB concentrations that did not significantly differ from those observed upstream of Walker Drain. Observed lipid corrected PCB levels in the Thames River upstream and downstream sites did not differ significantly from each other, but were significantly lower than those observed in the fish from the Pottersburg Creek sites. Nissouri Road, the upstream control location, was not included in the statistical analysis since only one composite sample was analyzed from this location. Total PCB residues in this sample were below detection (< 0.005 ppm).

Comparisons to historical data showed that there continues to be a downward trend in total PCBs in juvenile fish from Pottersburg Creek (Tables 5 & 6, Figures 6-7). The Wavell Street location showed a 90% PCB decrease between 1988 and 2008, but remains above the IJC guideline (0.1 ppm). The Walker Drain location demonstrated an 86% decrease in mean total PCBs since 1989 (Tables 5 & 6); however, this location continues to demonstrate elevated PCB levels and has the highest mean total PCB value of all sites sampled (Figure 7). The Thames River – Upstream location showed a slower rate of change compared to the other sites, however, the levels remain very low. Both Thames River locations are now below the IJC guideline for the protection of fish-eating wildlife (0.1 ppm).

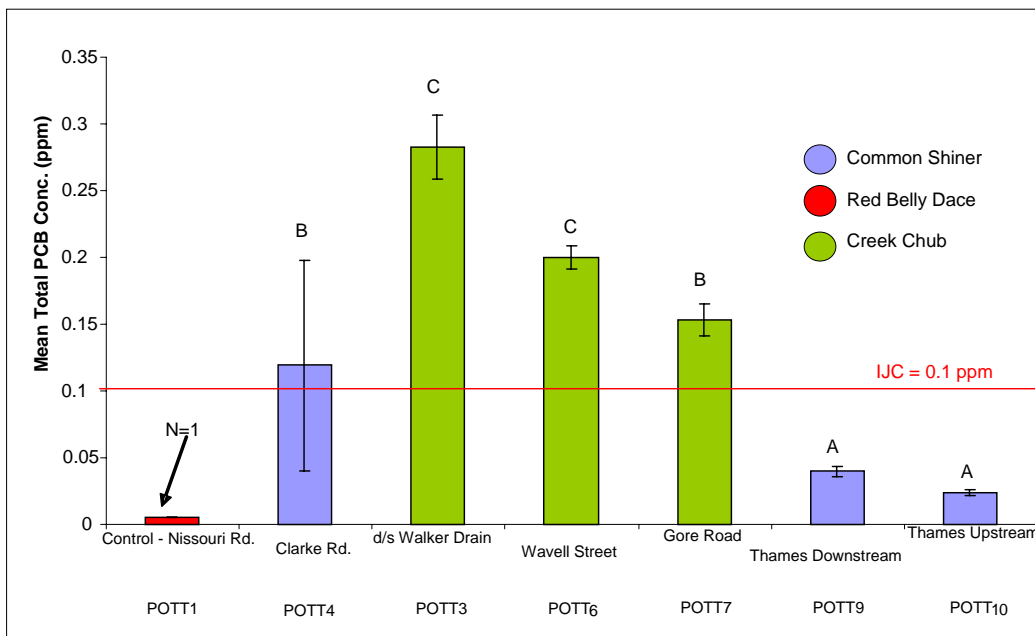


Figure 5. PCBs in juvenile fish collected from Pottersburg Creek in 2008. Lipid-corrected PCBs in fish from sites with similar letters do not differ significantly from each other (ANOVA, $p < 0.05$).

Table 5. Percent decrease in mean total PCBs (ppm) in juvenile fish from Pottersburg Creek between 2008 and the last year of collection.

Site	Previous Year	Previous Mean (ppm)	2008 Mean (ppm)	% Decrease
POTT4 - Clark Sideroad	2000	0.392	0.119	70
POTT3 - Walker Drain	1989	2.036	0.283	86
POTT6 - Wavell Road	1988	1.976	0.2	90
POTT7 - Gore Road	1997	0.56	0.153	73
POTT10 - Thames Upstream	1991	0.036	0.024	34
POTT9 - Thames Downstream	1995	0.318	0.041	87

Table 6. Summary of PCB concentrations (ppm) observed in juvenile (a) and sport fish (b) from Pottersburg Creek and the Thames River in the vicinity of Pottersburg Creek for the MOE 2008 study and findings from past investigations. Highlighted cells exceed the IJC* guideline for juvenile fish (0.1 ppm) and the SFCMP*** first consumption restriction level (0.105 ppm) for sport fish.

(a) Juvenile Fish

Source	year	U/S ref POTT1	D/S GM POTT4	U/S Walker Drain POTT2	Walker Drain POTT3	PC D/S Walker Drain POTT5	Second St POTT5A	Wavell Rd POTT6	Gore Rd POTT7	Mouth of PC POTT7A	D/S Thames R POTT9	U/S Thames R POTT10
MOE	2008	ND	0.07-0.21		0.25-0.3			0.19-0.210	0.14-0.16		0.037-0.046	0.021-0.027
		U/S ref	D/S GM P2	U/S Walker Drain P1	Walker Drain P3	PC D/S Walker Drain P4	Second St P5/6	Wavell Rd P8	Gore Rd P11	Mouth of PC	D/S Thames R	U/S Thames R
MOE	1980								2.69-4.01		0.924-1.161	0.171-0.253
	1984			25-83.5					1.4-11.5		1.7-4.5	0.15-1
	1985	ND-0.070		4.4-12.3	41.3-58.1				4.5-6.24		1.17-1.71	0.15-1.1
	1986			2.7-3.76					1.59-4.35		0.353-0.448	0.032-0.154
	1987			1.25-8.87	5.2-12.3				2.6-4.44		0.667-0.843	ND -0.399
	1988			1.53-3.17	3.12-4.7			1.2-3.2	0.46-0.98		0.22-0.41	0.08-0.17
	1989			0.1-0.86	1.88-2.2				0.2-0.32		0.12-0.15	ND
	1990			0.355-0.545					0.28-0.33		0.14-0.185	ND
	1991			0.38-0.72					0.4-0.6		0.14-0.2	ND-0.08
	1992			0.36-0.42					0.33-0.49			
	1993			0.341-0.51					0.326-0.464		0.235-0.259	
	1994			0.24-0.47					0.28-0.68		0.18-0.25	
	1995			0.46-1					0.3-0.44		0.16-0.44	
	1997			0.4-0.52					0.46-0.64			
	2000			0.3-0.56								

(b) Sport Fish

Source	year	U/S ref POTT1	D/S GM POTT4	U/S Walker Drain POTT2	Walker Drain POTT3	PC D/S Walker Drain POTT5	Second St POTT5A	Wavell Rd POTT6	Gore Rd POTT7	Mouth of PC POTT7A	D/S Thames R POTT9	U/S Thames R POTT10
MOE	2008										ND-0.54	ND-0.14
		U/S ref	D/S GM P2	U/S Walker Drain P1	Walker Drain P3	PC D/S Walker Drain P4	Second St P5/6	Wavell Rd P8	Gore Rd P11	Mouth of PC	D/S Thames R	U/S Thames R
MOE	1985										0.243-2.782	0.126-2.615
55-65cm carp	1985										0.075-0.65	ND-0.073
15-20cm rock bass	1985										0.025-0.032	
25-35cm smallmouth bass	1989										0.24-1.3	0.08
55-65cm carp	1998											

IJC* IJC (International Joint Commission) (1988) Revised Great Lakes Water Quality Agreement of 1978, as amended by protocol signed November 18, 1987. 130pp. International Joint Commission
SFCMP**** Sport Fish contaminant Monitoring Program - sport fish consumption advisory first level of restriction
ND Below method detection limit (<0.02 ppm)

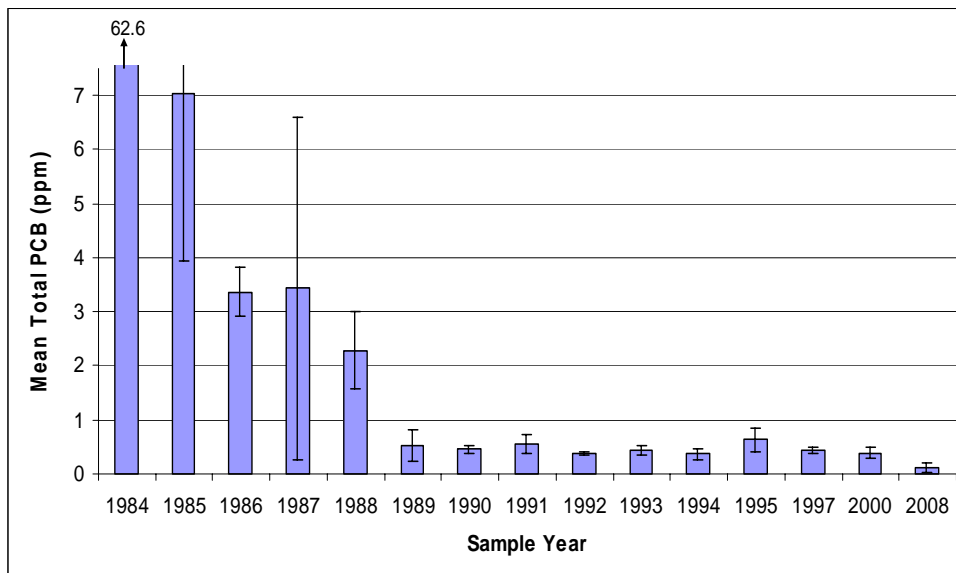


Figure 6. Mean total PCBs in common shiner collected from Pottersburg Creek – Clark Sideroad (POTT4) 1984-2008. Error bars represent standard deviation.

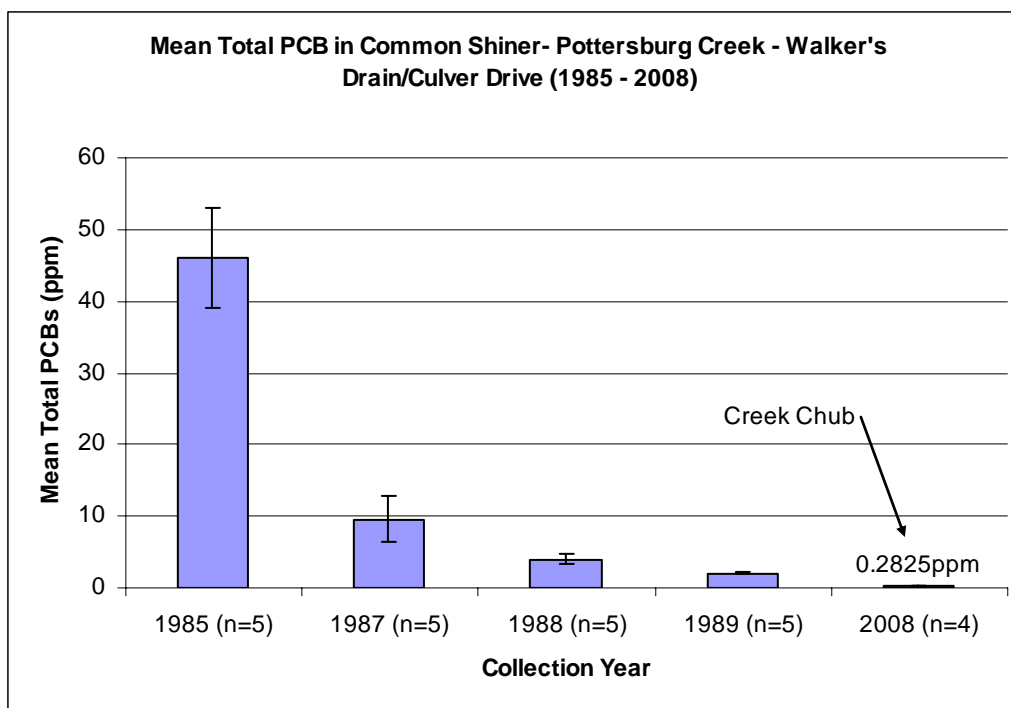


Figure 7. Mean total PCBs in common shiner collected from Pottersburg Creek - Walker Drain/Culver Drive (POTT3) 1985-2008. Error bars represent standard deviation. Collection from 2008 consisted of creek chub.

Sport Fish

Carp, smallmouth bass and rock bass were collected from the Thames River both upstream and downstream of Pottersburg Creek. For comparison purposes, carp were standardized to 55-65cm, smallmouth bass to 25-35cm and rock bass to 15-20cm. Mean PCB concentrations in carp were statistically significantly higher downstream of Pottersburg Creek compared to the upstream location (t-test, $p=0.052$), with the mean PCB concentration downstream more than 3 times higher than the upstream value and exceeding the second level of consumption restriction (0.211 ppm) (Table 6 and Figure 8). Similarly, mean PCB values in smallmouth bass also differed significantly between upstream and downstream sites (t-test, $p=0.064$, Figure 9). PCB concentrations in rock bass did not differ significantly between the upstream and downstream locations (t-test, $p=0.249$, Figure 10). PCB levels in both smallmouth bass and rock bass were below the first level of consumption restriction.

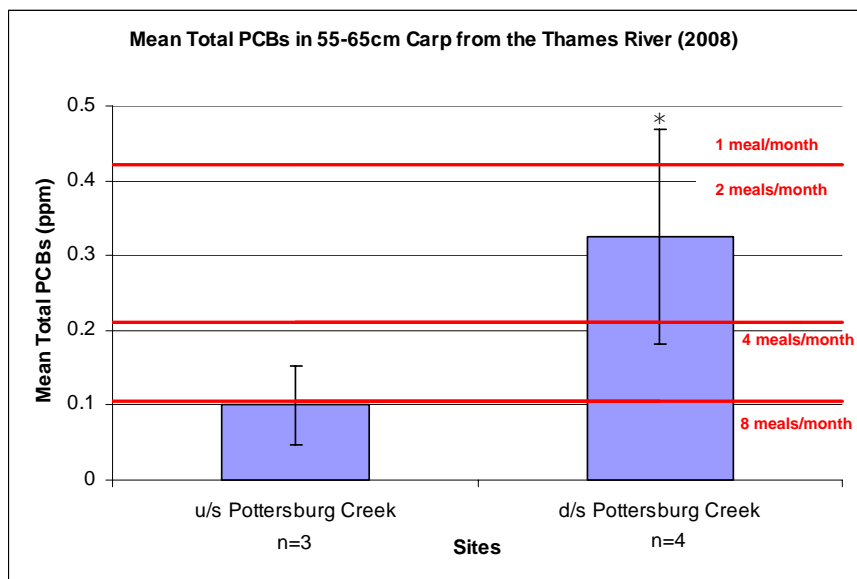


Figure 8. Mean total PCB concentration in 55-65cm carp from the Thames River, upstream and downstream of the Pottersburg Creek mouth (2008). The red horizontal lines indicate the consumption limits for PCBs in sport fish (0.105, 0.211 and 0.422 ppm). Bars labelled with an asterisk indicate significant differences (t-test, 90% confidence limit).

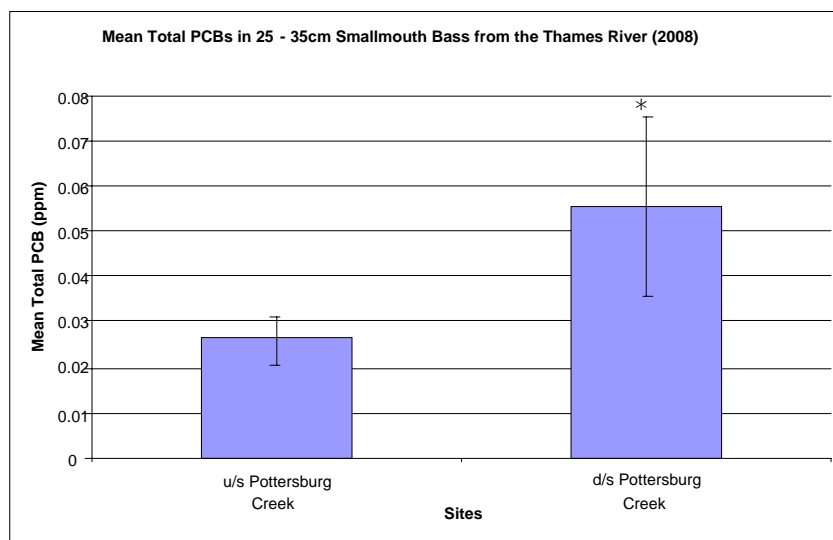


Figure 9. Mean total PCBs in 25-35cm smallmouth bass from the Thames River, upstream and downstream of the Pottersburg Creek Mouth (2008). Bars labelled with an asterisk indicate statistically significant differences (t-test, 90% confidence limit).

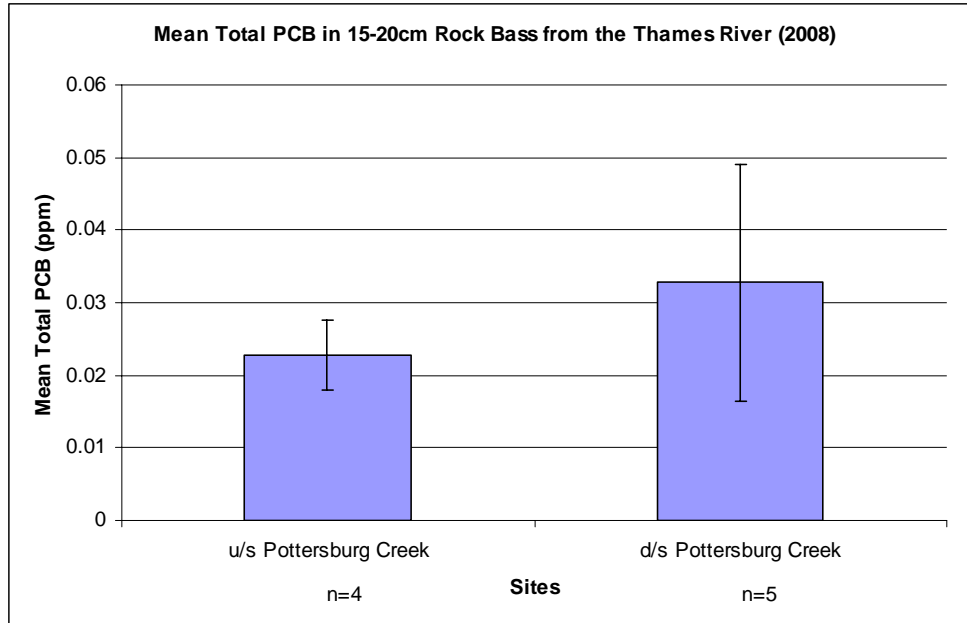


Figure 10. Mean total PCBs in 15-20cm rock bass from the Thames River, upstream and downstream of the Pottersburg Creek Mouth (2008).

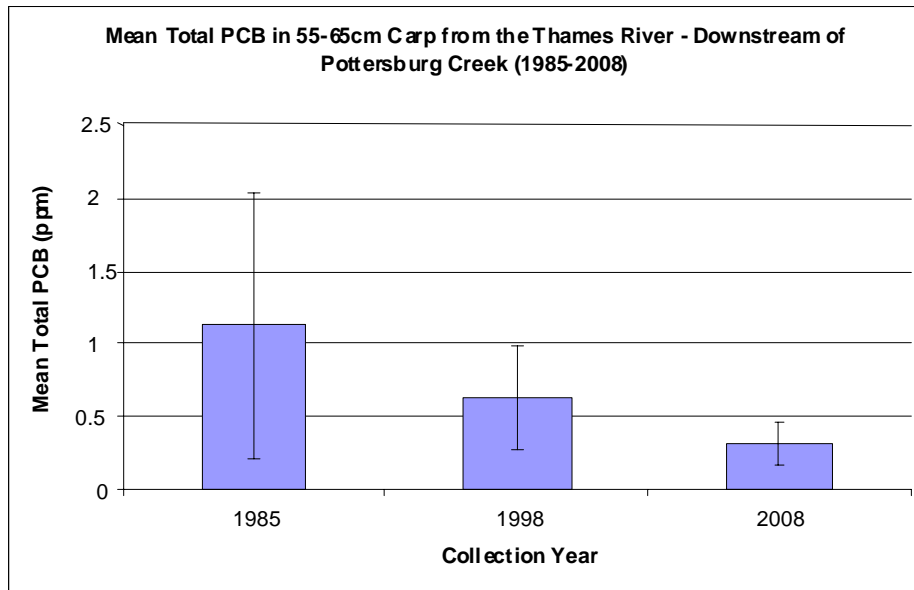


Figure 11. Mean total PCBs in 55-65cm carp from the Thames River - Downstream of Pottersburg Creek (1985-2008).

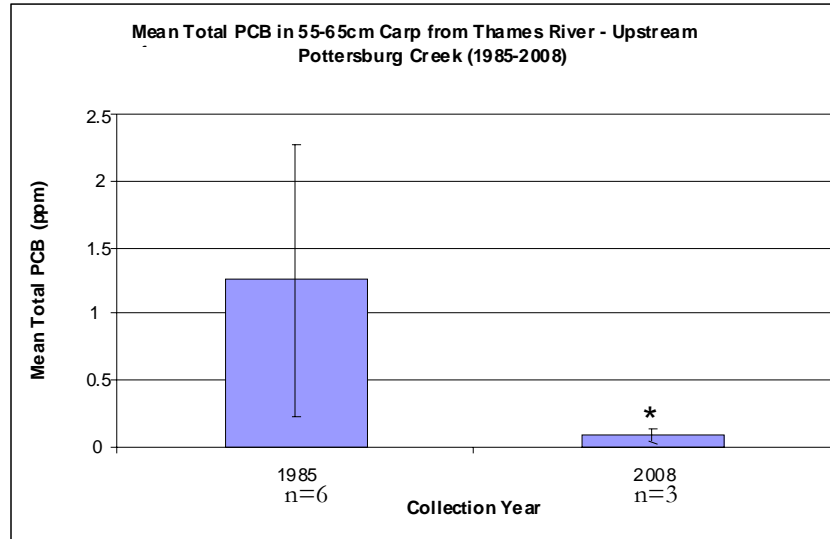


Figure 12. Mean total PCBs in 55-65cm Carp from Thames River - Upstream of Pottersburg Creek (1985-2008). Bars labelled with an asterisk indicate significant differences (t-test, 90% confidence limit).

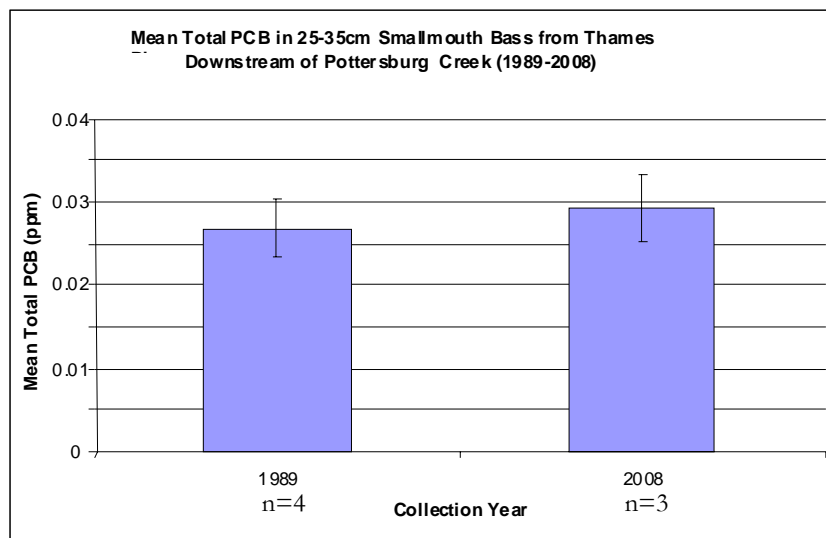


Figure 13. Mean Total PCBs in 25-35cm Smallmouth Bass from Thames River - Downstream of Pottersburg Creek (1989-2008).

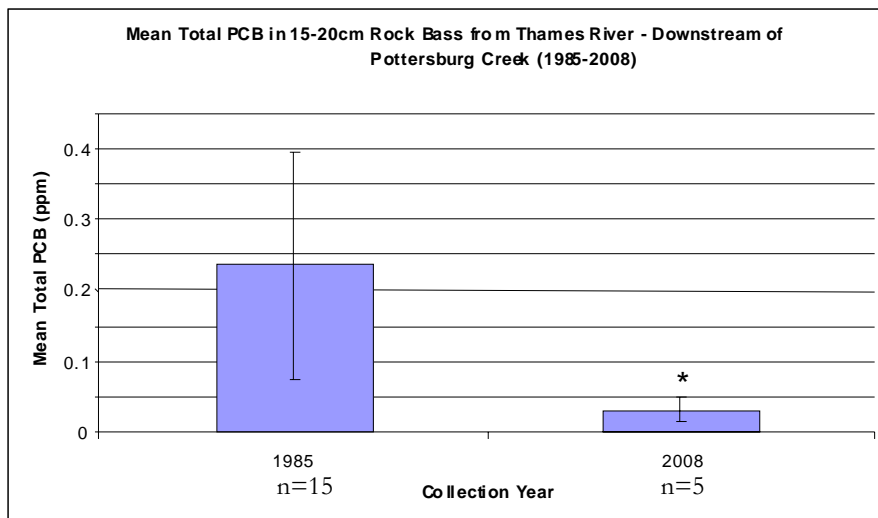


Figure 14. Mean Total PCBs in 15-20cm Rock Bass from Thames River - Downstream of Pottersburg Creek (1985-2008). Bars labelled with an asterisk indicate significant differences (t-test, 90% confidence limit).

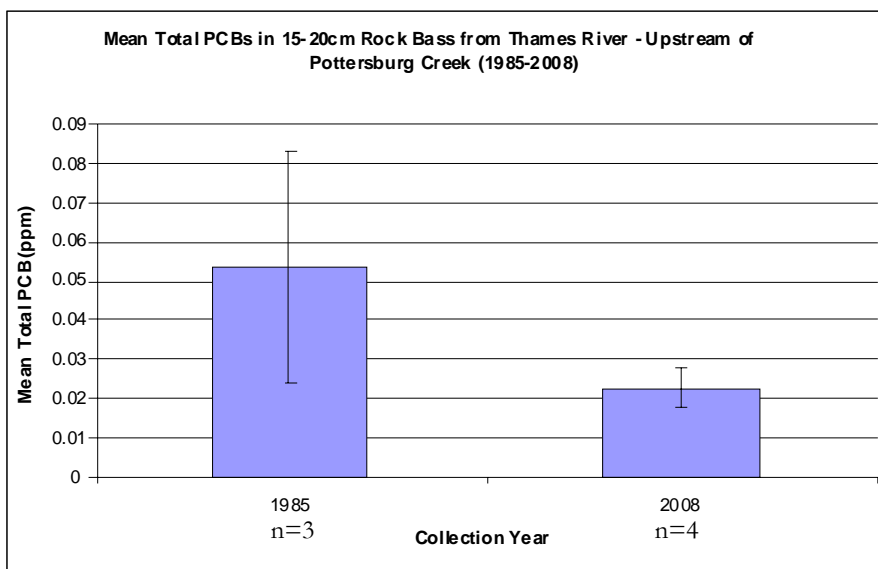


Figure 15. Mean Total PCBs in 15-20cm Rock Bass from Thames River - Upstream of Pottersburg Creek (1985-2008).

Downstream of Pottersburg Creek, a distinct decline in mean levels of PCBs in carp is found between 1985 and 2008, although these trends were not statistically significant (ANOVA, $p=0.11$, Figure 11). A statistically significant decrease, however, was found in mean PCB concentrations from upstream of Pottersburg Creek (t-test, $p=0.038$, Figure 12). The only available historic data for smallmouth bass were from samples collected downstream of Pottersburg Creek. PCB concentrations from these collections did not

differ significantly from bass collected in 2008 immediately downstream of the creek (t-test, $p=0.42$, Figure 13). A significant decrease in mean PCBs between 1985 and 2008 was found in rock bass from downstream of Pottersburg Creek (t-test, $p<0.001$, Figure 14); however, despite a similar trend, no significant differences were observed in rock bass between years for the upstream location (t-test, $p=0.206$, Figure 15).

Discussion

- The 2008 data suggest that PCB residues in all media are elevated in and near the Walker Drain at Culver Road. Concentrations decrease downstream of the Walker Drain (Wavell St. and Gore Road). PCB concentrations in sediment, water and juvenile fish from the Walker Drain all exceeded their respective guidelines (Table 2, 3, 6a), suggesting that PCBs in this area could pose a concern to aquatic wildlife.
- A decreasing trend over time was observed in PCB concentrations in all media. However, PCB concentrations in sediments and juvenile fish still remained above their respective guidelines at most locations.
- PCB levels in all media upstream of the Walker Drain (Clark Rd.) are slightly elevated compared to the upstream Pottersburg Creek reference, but are generally lower than sites downstream of the confluence of the Walker Drain.
- PCB concentrations in the sediments at the downstream Thames River location were over twenty times higher than at the upstream location, and exceeded the PSQG LEL by a factor of 4. PCBs were also higher in the Thames River downstream of Pottersburg Creek in carp and smallmouth bass. These data suggest that Pottersburg Creek may be contributing to PCBs in the Thames River. However, PCB concentrations in clams, juvenile fish and rock bass from Thames River upstream versus downstream did not differ significantly and levels in smallmouth bass and rock bass were below consumption advisory criteria for the general population.
- Although in some cases (e.g. sediments, water and sport fish) PCB levels in both the Walker Drain and the Creek remain elevated above their respective criteria, concentrations were much lower in 2008 than those observed in previous studies (Table 2, 3, 4 & 6). Comparisons between total PCB concentrations in water should be viewed with caution as different analytical methods were used to measure PCBs historically.
- PCB concentrations in Pottersburg Creek upstream of Walker Drain are generally similar to or slightly higher than reference locations of other industrial/urban areas where PCBs are a known concern (Table 7). In Walker Drain PCB concentrations were generally lower than the impaired urban/industrial locations listed in Table 7. It should be noted however that many of these sites show ‘pre-

clean-up' concentrations with known PCB sources while, based on historical and current data, PCBs have largely been removed from Pottersburg Creek. Down stream of Walker Drain, PCB concentrations are generally lower than in other industrial/urban areas with known PCB sources.

Table 7. PCB ranges for other industrial/urban areas of southern Ontario

			Clam (ppm)	Sediment (ppm)	Water (ppb)	Juvenile Fish (ppm)
Pottersburg Creek	U/S Walker Drain	2008	0.002-0.026	0.009-0.088	0.000174-0.00106	ND-0.21
	Walker Drain	2008	0.057-0.08	0.37-0.47	0.0167-0.0248	0.25-0.3
	D/S Walker Drain	2008	0.012-0.067	0.18-0.34	0.00420-0.00487	0.037-0.21
Nepahwin Lake (Sudbury)	impaired	2006-07	ND-0.165	0.004-0.988	0.0002-0.024	0.037-0.702
	reference		ND	0.007-0.033	0.000007-0.0004	0.029-0.04
Lake Clear (Near Eganville)	impaired	2004 & 2006	0.004-0.283	0.004-3.096	ND-0.187	0.18-3.7
	reference		ND-0.01	0.0161	ND	0.048-0.13
Lake St. John (near Orillia)	impaired	2005	0.009-0.08	0.014-3.13	ND	0.094-0.147
	reference		0.004-0.009	0.088-0.089	ND	0.058-0.086
Speed River (Guelph)	impaired	2005	ND-0.041	0.018-1.6	ND	0.027-0.052
	reference		ND-0.007	0.032-0.033	ND	0.007-0.018
Sinister Creek (Lindsay)	impaired	2006	0.119-0.437	0.55-3.5	0.046-0.19	2.7-7.2
	reference		0.002-0.014	0.006-0.11	0.000005-0.005	0.27-0.61
Lyon's Creek (Welland)	impaired	2002/03	0.004-0.3978	0.23-7.5	-	0.32-11.292
	reference		0.0057-0.0078	ND-0.06	-	0.009-0.057
Humber River (Toronto)	known source	2000-03	-	-	-	0.024-0.312
Etobicoke Creek (Toronto)	known source	2000-03	-	-	-	ND-0.56
Usshers Creek (Niagara)	reference creek	2002/03	0.0067-0.0072	0.0055-0.013	-	0.013-0.033
Black Creek (Niagara)	reference creek	2002/03		0.0025-0.004	-	0.011-0.047
Beaver Creek (Niagara)	reference creek	2002/03	0.0046-0.00758	0.012-0.016	-	0.009-0.015
Toronto Waterfront	typical urban area	2000-03	-	-	-	0.047-0.08

Explanatory notes:

Impaired – a sample known to be from an area of PCB contamination

Reference – a sample known to be outside of an area of PCB contamination

Known Source – an area where there is a known source of PCBs and elevated levels are observed in the biota

Reference Creek – sample taken from a rural creek with no known PCB inputs

Conclusions

- Elevated concentrations of PCBs in surface water, sediment, and biota demonstrate PCBs are elevated in environmental media and bioavailable to aquatic biota.
- A decreasing trend over time was observed in PCB concentrations in all media. However, PCB concentrations in water, sediments and juvenile fish still remained above their respective guidelines at most locations.
- Although in some cases PCB levels in both the Walker Drain and the Creek remain elevated above their respective criteria, concentrations were much lower in 2008 than those observed in previous studies.
- Observed exceedences of the PSQG LEL and evidence of biomagnification potential in juvenile fish and clams indicates additional assessment is needed to determine if the potential is of concern.